

# Chapter Two

## COST-SAVING BUILDING TECHNOLOGIES AND CONSTRUCTION TECHNIQUES

**T**he cost-saving construction methods presented in this model are technically oriented, and focus on the design and construction of particular features in and around the home. They can be generally classified into basic suggestions that:

- Substitute materials that are less expensive to purchase and/or install than more common alternatives. Examples include use of less expensive sheathing products, plastic plumbing products instead of copper, and corrugated stainless steel gas pipe instead of black iron pipe;
- Involve more innovative alternative products that simplify overall construction, such as mechanical plumbing vents in lieu of through-the-roof vent pipes, or frost-protected shallow foundation systems instead of deep footings in cold climates;
- Save money by eliminating overdesigned or unnecessary features, including 24-inch stud spacing rather than 16-inch, 2 x 3 studs instead of 2 x 4s in nonbearing walls, and reduced plumbing vent pipe sizes; and
- Focus on residential land planning and land development, such as increased density, clustered development, reduced street widths, and elimination or simplification of technically questionable development requirements.

### DESCRIPTION OF TECHNOLOGIES AND TECHNIQUES

Detailed descriptions of the cost-saving technologies and techniques are organized by phase of construction or building system.

Resources for further information are cited for each method. Publications that are available from HUD USER are noted first, followed by other easily located references. HUD USER makes printed copies of recently published materials

from the U.S. Department of Housing and Urban Development available, and provides reference specialists to help access the information requested. Call 1-800-245-2691 or 301-251-5154, or write HUD USER, P.O. Box 6091, Rockville, MD 20850. Organizations that may be able to provide additional assistance or information are also listed.

Although the cost-saving suggestions described in this chapter are widely recognized, they are not universally accepted by building code officials. Entries include information about the acceptability of individual suggestions under the major U.S. model codes, which include the *CABO One- and Two-Family Dwelling Code*, the series of codes published by Building Official Code Administrators International, Inc., Southern Building Code Congress International and International Conference of Building Officials, and the *National Electrical Code*. Applicable codes should be reviewed with appropriate local officials before introducing new methods into the construction or rehabilitation of any building.

### FOUNDATIONS

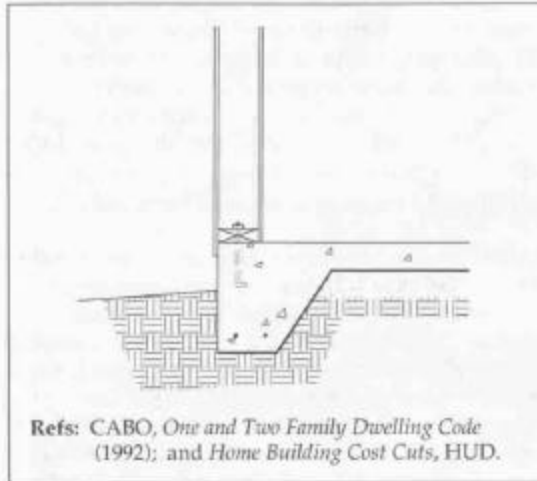
Foundations typically consist of a concrete block or poured concrete wall placed on top of a concrete spread footing that rests on the soil. They are designed to support all building loads safely, and are located at a depth that is sufficient to prevent frost heave. New methods and materials that achieve these design objectives have been gaining popularity as cost-saving alternatives to the more traditional approaches. Methods and materials that offer potential savings are discussed below.

#### Monolithic Slab-on-Grade Foundation

The number of steps involved in foundation construction can be reduced by using a monolithic slab-on-grade foundation design. A monolithic slab-on-grade

installation consolidates the operations of casting a separate footing and pouring a floor slab. This both reduces labor, and also cuts the time required to build a typical slab-on-grade foundation by 1 to 2 days. All model codes allow monolithic slabs. (Figure 1)

**Figure 1. Monolithic Slab-on-Grade Foundation**



### Stemwall Foundation

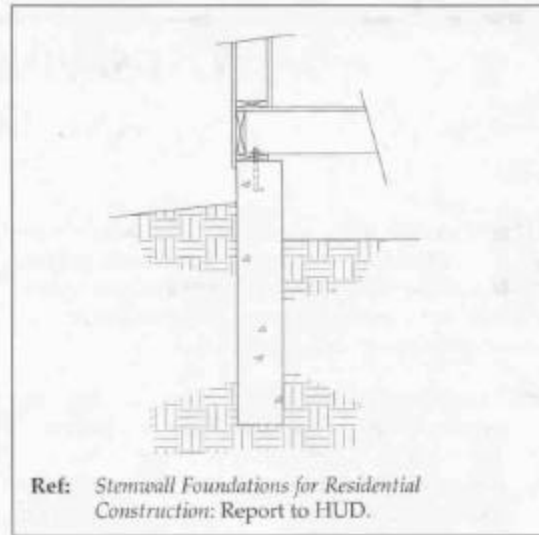
A stemwall foundation adapts the monolithic slab-on-grade concept to homes built on basement or crawlspace foundations. It offers similar advantages. The stemwall design allows for safe distribution of building loads directly from a concrete wall to the soil without the need for a separate spread footing. Stemwall foundations may require engineering analysis for code approval. Stemwall foundation design for a crawlspace is shown in Figure 2.

### Frost-Protected Shallow Foundation

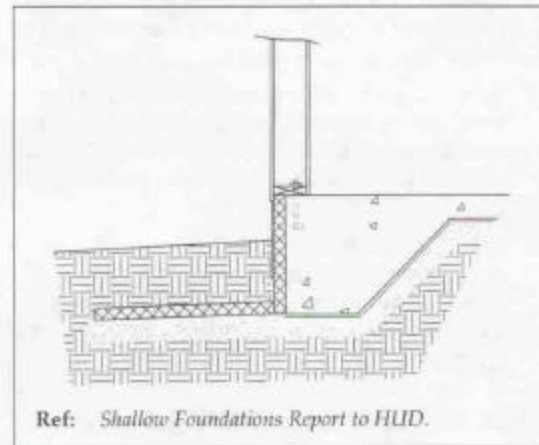
A frost-protected shallow foundation (FPSF) makes it possible to build slab-on-grade foundations that are as shallow as 16 inches, even in areas where the frost depth is 5 feet or more. Use of the FPSF technique saves trenching costs, concrete, and time when compared with a traditional deep foundation. This type of foundation is particularly useful in tight areas where deep excavations are impractical or impossible because of proximity to another building or a property line.

FPSFs can be built successfully at shallow depths because they use insulation to retain heat from inside

**Figure 2. Stemwall Crawlspace Foundation**



**Figure 3. Frost-Protected Shallow Foundation**



the building, which keeps the perimeter of the building warm and effectively raises the frost line. Exterior insulation must be placed vertically along the foundation on all FPSFs. In extremely cold climates, additional horizontal insulation is required to extend outward from the bottom of the footing for 1 to 2 feet. The insulation required for frost protection also increases the energy efficiency. FPSFs may require engineering analysis for code approval. (Figure 3)

## FRAMING

Framing offers some of the best opportunities to reduce costs during rehabilitation and new construction. Considerable effort has been directed at value-engineering residential framing. Although much of this work took place in the 1970s under HUD's Operation Breakthrough and similar programs, the increasing and highly volatile costs of lumber and plywood make suggestions for reducing framing expenses relevant today. Examples of some of the most widely used cost-saving methods are discussed below. See the section entitled Alternatives to Lumber and Plywood for additional suggestions.

### Use of Optimum Value-Engineered (OVE) Framing

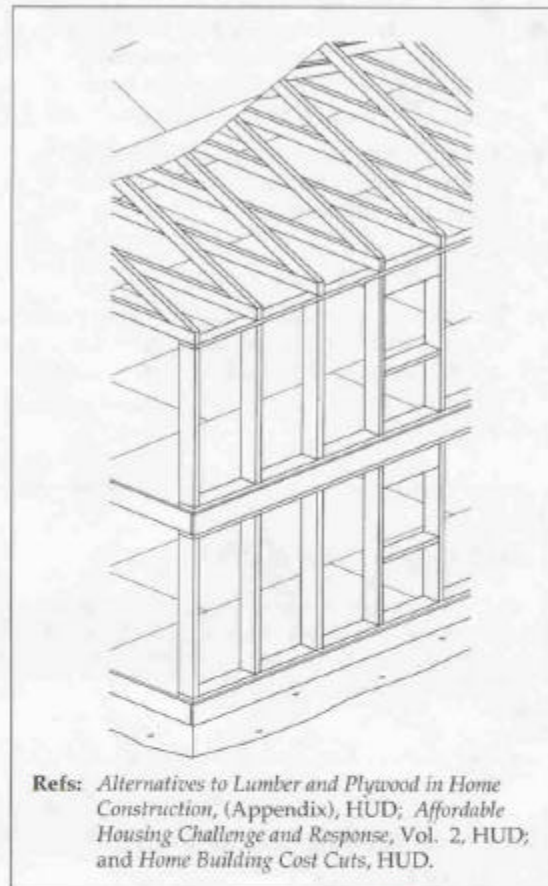
The OVE design and construction system was developed in the 1970s to increase the efficiency of lumber use in home building. OVE in-line framing is an important part of the OVE approach. (Figure 4.) With in-line framing, all floor, wall, and roof framing is spaced identically so the respective structural members bear the load directly over each other. Thus, loads from the roof and walls are transferred directly through the lower members to the foundation. The result is a more efficient structure and a reduction in or elimination of some of the framing members used to distribute the load. In high wind or seismic areas, be sure to check with local code officials to determine whether this technique is appropriate before deviating from approved framing practices.

The most economical spacing for structural members using the OVE method is 2 feet, compared with traditional 16-inch spacing. Descriptions of this and other OVE techniques follow. (Figure 4)

### Increased Spacing of Framing Members

Conventional framing typically uses members spaced 16 inches on center. It is widely recognized, however, that 24-inch on-center stud, joist, and truss spacings are acceptable for structural purposes. Perhaps the most broadly applicable of these measures is 24-inch spacing of 2 x 4 partition wall studs. All major U.S. model codes also permit 24-inch spacing for 2 x 4 studs in bearing walls in all one-story applications, and for the

Figure 4. OVE Framing



**Refs:** *Alternatives to Lumber and Plywood in Home Construction*, (Appendix), HUD; *Affordable Housing Challenge and Response*, Vol. 2, HUD; and *Home Building Cost Cuts*, HUD.

top story of multiple story homes. Where 2 x 6 studs are used, they can be spaced at 24 inches for both one- and two-story homes.

Increased spacing both saves framing lumber, and improves energy efficiency because it increases the proportion of overall wall area that can contain cavity insulation. (Figure 4)

### Eliminate Unnecessary Framing

Over the years, residential framing methods have evolved based largely on tradition. As a result, unneeded framing members have found their way into conventional practice. For example, model codes now recognize:

- Mid-height fire blocking can be eliminated in walls;

- Floor bridging is unnecessary for joists sized at 2 x 12 or less;
- Structural headers (e.g., double 2 x 6s, 2 x 8s, or 2 x 10s) are not needed in openings in nonbearing walls and partitions (a flat 2 x 4 can be used in the opening as a nailing surface);
- A single top plate is sufficient in nonbearing partition walls, as well as in bearing walls if in-line framing is used;
- Ceiling heights can be reduced to 7' 6" to save both materials and labor; and
- Traditional three-stud corners can be replaced with two-stud corners in all applications, with metal drywall clips (instead of a third stud) used to fasten the interior wall surface. (Figure 5)

#### Savings From the Use of OVE Techniques

Most builders in the Joint Venture for Affordable Housing used OVE techniques. Their cost-savings are documented in *Affordable Housing Challenge and Response*, Vol. 2, HUD, pp. 43-52.

#### Structural Wall Sheathing Only for Required Bracing

To resist wind-induced "racking" forces, exterior walls of homes have historically been covered with plywood or 1" board sheathing. More recently, the major U.S. model codes have recognized that bracing installed in corners effectively resists the loads on homes less than three stories in height. In walls more than 25 feet in length, an additional intermediate section of wall should also be braced. In seismic zones 3 and 4, additional sheathing or bracing is required for multi-story buildings.

Corner bracing can consist of a 4-foot section of structural sheathing (e.g., plywood), 1" x 4" diagonal let-in braces, or approved metal straps. Where plywood or Oriented Strand Board (OSB) corners are used, the rest of the wall can be covered with a less expensive material of equivalent thickness, such as insulation board. (Figure 6)

Figure 5 - Two Stud Corner

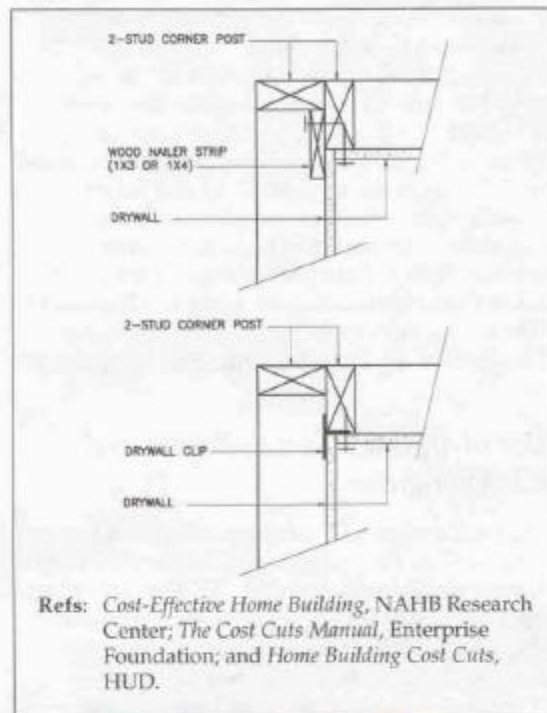
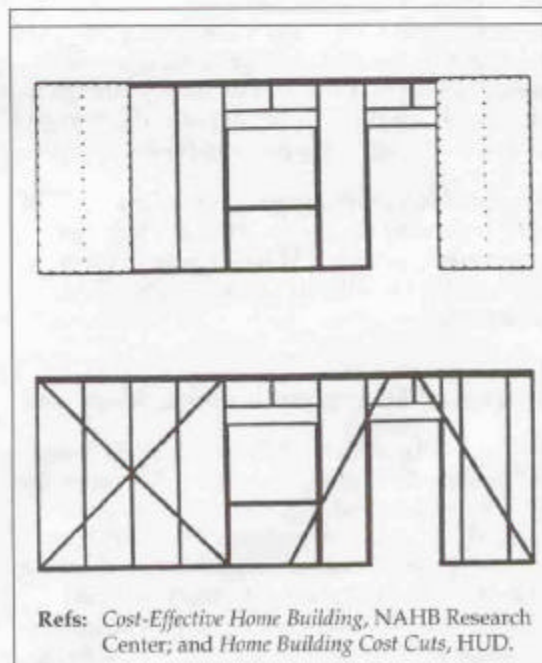


Figure 6 - Corner Bracing



## 2 x 3 Partition Studs

The most common type of wall stud used for interior partition framing is the 2x4. By substituting 2 x 3 studs for interior nonbearing partitions, material costs can be reduced without sacrificing structural integrity. The 2 x 3 studs can even be placed at 24" on center. This practice is acceptable under all the model codes.

For additional information, see *Alternatives to Lumber and Plywood in Home Construction*, HUD; *The Cost Cuts Manual*, Enterprise Foundation; and *Cost-Effective Home Building*, NAHB Research Center.

## Prefabricated Wall Panels

Stick-built on-site construction is the predominant approach to building homes in the United States. In some cases, however, it is more cost-effective to purchase wall panels that are manufactured off-site and delivered to the building site. Use of prefabricated wall panels can shorten the construction schedule and reduce related carrying costs (interest on construction funds). Wall panels are available from a variety of panel manufacturers and truss manufacturers in two basic types—closed-wall and open-wall.

In closed-wall panels, utilities, insulation, drywall, and sheathing all are installed by the panel manufacturer at the factory. Exterior and interior finishes must be protected from damage and moisture during transportation to the site. Closed wall panels typically require an inplant inspection by a State-recognized third party agency.

In open-wall panels, wall studs and exterior sheathing are installed in the plant, but plumbing, electrical, and mechanical equipment may be installed at the plant or on site, which makes site inspection easy. Drywall, insulation, and other finish materials are generally installed on site. Open-wall panels are less vulnerable to damage during transportation than closed panels, and are used in all areas of the United States.

For more information contact the Building Systems Council, 1201 15th Street NW, Washington, DC 20005, (202)822-0576. Also see, "Automated Builder Dictionary/Encyclopedia of Industrialized Housing," *Automated Builder Magazine*.

## ALTERNATIVES TO LUMBER AND PLYWOOD

Although wood continues to be one of the most cost-effective building materials, recent rising and unstable prices have increased the pressure for alternative materials. Many options currently exist, but their competitiveness depends on several variables including local labor rates and availability. Following are examples of products that could offer a competitive advantage over lumber or plywood.

### OSB or Laminated Fiberboard Structural Sheathing

For decades, plywood has been the exterior wall covering of choice for most builders because of its strength and relative low cost. As plywood and lumber prices have risen, however, more and more builders have begun to use Oriented Strand Board (OSB) or laminated fiberboard. Although these products are less expensive than plywood, the resistance to change that new products often encounter has limited their use to some degree.

OSB is an engineered wood product made from small strands of wood blended with a resin and oriented in layers. It is widely available in 4' x 8' sheets, and can be used for floor, roof, and wall sheathing. OSB is recognized in all the major model U.S. codes. Its installation is identical to plywood.

Laminated fiberboard structural sheathing is made from wood byproducts. It is produced in panel form. These products typically consist of fibrous plies laminated under pressure and covered with foil or polyethylene. Although not specifically addressed in most codes, several manufacturers have obtained evaluation reports on their products from the Council of American Building Officials and the International Conference of Building Officials. These listing reports are usually sufficient to gain local approval.

For more information on engineered wood products, contact the American Forest and Paper Association, 1111 19th Street NW, Washington DC 20036, (202)463-2700. Also see, *Alternatives to Lumber and Plywood*, HUD.

## Plastic or Wood-Plastic Lumber

Trim, decking, fences, and other finish items account for a substantial percentage of the wood used in residential construction. Plastic-based products are beginning to see more use for these types of nonstructural applications. Products in this category include 100 percent plastic lumber and newer products that are composed of 50 percent plastic and 50 percent wood. (These latter products often incorporate recycled consumer plastics and wood scraps.) See *Alternatives to Lumber and Plywood in Home Construction*, HUD, for additional information on this subject.

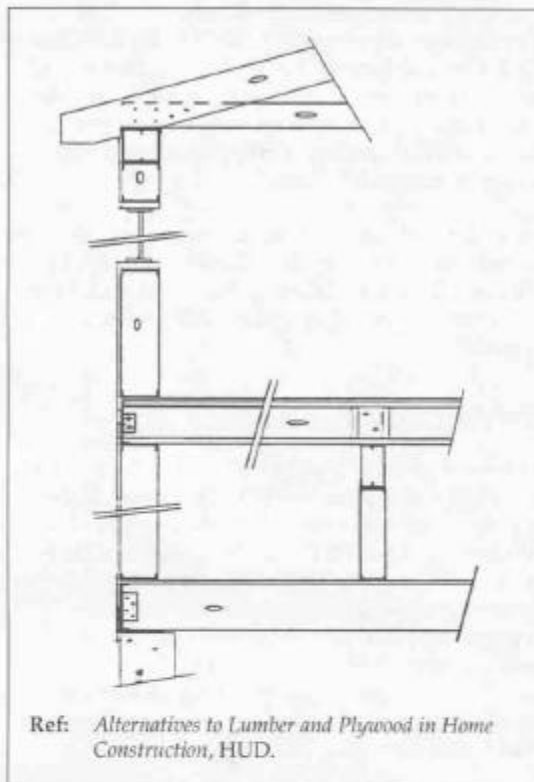
## Steel Framing

In some regions of the United States, steel has always been competitive with wood for interior partition framing. Most drywall contractors are familiar with steel partitions because they are widely used in commercial construction. Recently, an increasing number of home builders have begun to use steel for load-bearing applications. Manufacturers offer steel as a stick-for-stick replacement for individual wood members, or as a panelized system. Like nearly all wood alternatives, the cost-effectiveness of steel for structural components such as floors, walls, and roofs depends on availability and local labor and material costs.

All major U.S. model building codes permit the use of steel both for partition studs and use in load-bearing applications—provided that the plans are designed and certified by a competent professional in accordance with code-approved standards. Many steel manufacturers supply design assistance along with their product.

Some construction details that must be addressed with steel framing include the need for special fasteners (screws instead of nails), and the need for insulating grommets to protect electrical wiring from damage and to prevent direct contact between copper water pipes and steel studs. (Figure 7) For more information on steel framing for home construction, contact the American Iron and Steel Institute (AISI), 1101 17th Street N.W., Washington, D.C. 20036, (202)452-7100.

Figure 7. Steel Framing Wall Section



## ELECTRICAL

Electrical installations are typically governed by provisions of the National Electrical Code or similar local codes. Even within these stringent codes, however, there are ways to reduce costs using low-cost products that meet the intent of the code. Examples of cost-saving techniques and materials that have been widely accepted are discussed below.

### Surface-Mount Electrical Conduit and Behind-Baseboard Installation

Traditional methods for installing electrical wiring inside walls work well with new construction, but this approach is much more difficult and costly in rehabilitation work. Surface-mount electrical conduit and behind-baseboard installations are two alternative approaches.

Surface-mount conduit is fairly well known, but behind-baseboard, or baseboard raceway systems, are likely to be more acceptable to occupants. An example of this type of system is a plastic baseboard that has a hollow space to fish electrical wiring through. Some systems have multiple raceways built into the baseboard so that a number of cables can be routed through the system. Both surface-mount and behind-baseboard systems are recognized and governed by provisions in the National Electrical Code.

### **Savings from Surface-Mount Conduits and Baseboard Raceways**

Installing surface-mount electrical conduits or baseboard raceways can save from 25 to 40 percent on electrical costs when compared with traditional methods of running electric wire. Surface mounting leaves sound walls undisturbed and avoids problems with concrete floors.

Ref: *The Cost Cuts Manual*, Enterprise Foundation, pp. 4-16 to 4-124.

### **Plastic Electrical Boxes**

In many areas, metal electrical boxes are the norm for light switches, wall outlets, and other applications. The plastic electrical box, however, is a low-cost alternative that is widely available and relatively simple to install. Plastic electrical boxes are generally acceptable under the National Electrical Code when used with nonmetallic sheathed cable.

### **Savings from Plastic Electric Boxes**

Typically, plastic electrical boxes are at least 10 percent less expensive and 20 percent more efficient than traditional metal boxes.

Ref: *Cost Cuts Manual*, Enterprise Foundation, pp. 4-16 to 4-124)

### **Install Fewer Electrical Outlets in Existing Buildings**

Although the National Electrical Code and other major codes generally require that there be an electrical outlet within 6 feet of any section of wall, other codes and guidelines have relaxed this requirement for rehabilitation projects. For example, under HUD *Rehabilitation Guidelines*, three outlets in kitchens and two in all other rooms is an acceptable minimum, which is consistent with requirements in the HUD Section 8 HQS, and the BOCA National Code for Existing Structures. Similar examples include standards for ground fault circuit interrupters, light fixtures, and switched outlets.

For more specific information on this subject refer to *Rehabilitation Guidelines*, HUD; and *The Cost Cuts Manual*, Enterprise Foundation.

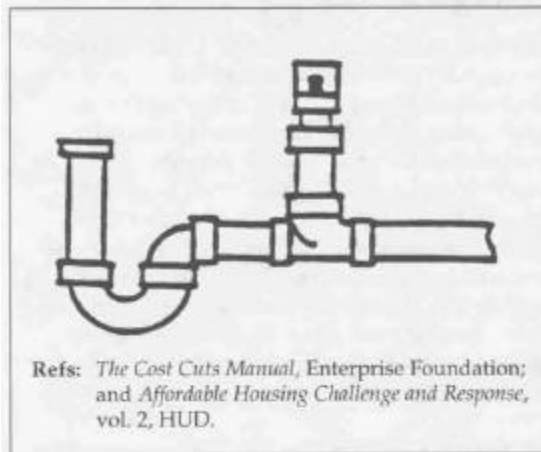
### **PLUMBING**

For years, plumbers have followed numerous rules of thumb which, although based on years of practical experience, do not apply to many of today's plumbing materials. Research that supports the newer cost-effective approaches has begun to find its way into the U.S. model codes. For example, the plumbing provisions in the CABO *One and Two Family Dwelling Code* were completely revised in the mid-1980s to reflect the latest research results. Cost-saving items that have recently evolved in the plumbing area are discussed below.

### **Mechanical Plumbing Vents**

Traditionally, plumbing vents are installed for each fixture and extend up through the roof. The introduction of mechanical vents has eliminated this need, instead allowing the vent to terminate just above the fixture. These devices are useful in situations where it is difficult to install vents for fixtures—they can eliminate the need to open additional walls and floors in a rehabilitation project. Mechanical vents are accepted in most major plumbing codes and are available through plumbing supply and building supply stores. (Figure 8)

**Figure 8. Mechanical Plumbing Vents**



### Direct Venting of Drain-Waste-Vent (DWV) Pipes

Like mechanical plumbing vents, direct venting is useful when it is difficult or costly to install a traditional "through-the-roof" plumbing vent. Direct vents are plumbing vents that terminate through a wall directly to the exterior. (They are sometimes called "sidewall vents" or "through-the-wall vents.") Before installing a sidewall vent, check to ensure that no nearby openings would allow sewer gas to reenter the building. Some of the more progressive U.S. codes (e.g., the CABO *One- and Two-Family Dwelling Code*) permit sidewall vents, however, requirements on where they can terminate vary from code to code.

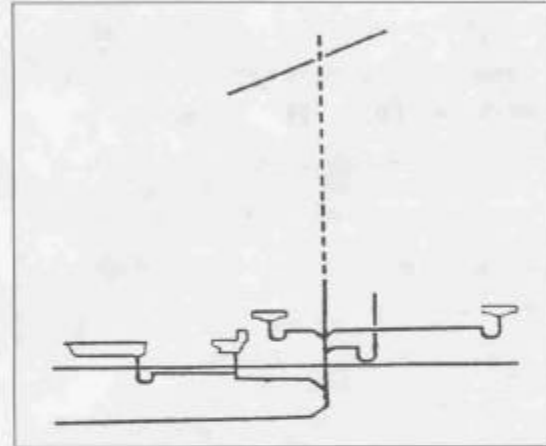
Refer to *The Cost Cuts Manual*, Enterprise Foundation, for additional information.

### Stack or Wet Venting of Drain-Waste-Vent Pipe

Stack and wet venting of DWV pipe minimize the amount of total pipe in the plumbing system by reducing the requirement for a separate vent for each fixture. For example, where plumbing fixtures on one floor are located above or below fixtures on another floor, both may be vented through the same pipe. In many circumstances the waste line for upper story fixtures can also

serve as the vent for the lower story fixtures. Each of these situations reduces the amount of piping when compared with more traditional methods that rely on a separate vent for each fixture or for each story. Both methods are allowed under the CABO, *One- and Two-Family Dwelling Code* (Figure 9).

**Figure 9. Schematic of Wet and Stack Vents**



### Savings from Cluster Plumbing

A builder in Valdosta, GA, redesigned house plans to cluster plumbing and, thereby, reduce both DWV piping and water supply piping. The resulting cost savings averaged \$400 per home. (1985) (*Affordable Housing Challenge and Response*, Vol. 2, HUD, pp. 58-66)

Refs: *Rehabilitation Guidelines: Plumbing DWV Guidelines for Residential Rehabilitation*, HUD; and *The Cost Cuts Manual*, Enterprise Foundation.

### Pipe Materials

In most major model codes, acceptable water service pipe materials include polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polybutylene, polyethylene, and other plastics that are often less costly than copper pipe. For example, polybutylene plastic pipe, a flexible pipe that requires fewer fittings than rigid pipe, is

easier to install and thus less costly than rigid pipe. PVC and polyethylene water service pipe should only be used for cold water distribution. Check local codes for acceptance of all nontraditional materials.

#### **Savings from Use of Alternate Pipe Materials**

Polybutylene supply pipe was used instead of copper in a Phoenix, AZ, subdivision. As a result, plumbing costs were reduced by \$65 per unit. (1985) (*Affordable Housing Challenge and Response*, Vol. 2 HUD, pp. 58-66) Field studies have shown 30 to 50 percent savings when flexible polybutylene supply piping is substituted for rigid pipe materials. (1987) (*Affordable Housing Challenge and Response*, Vol. 2, pp. 58-66)

Ref: *The Cost Cuts Manual*, Enterprise Foundation; and *Home-Building Cost Cuts*, HUD.

## **FINISHES AND TRIM**

The finish stages of construction offer additional opportunities for cost savings in both new construction and rehabilitation projects. Although many of the suggestions provided here are not new or innovative, they are included because they are cost-saving alternatives to existing methods and materials.

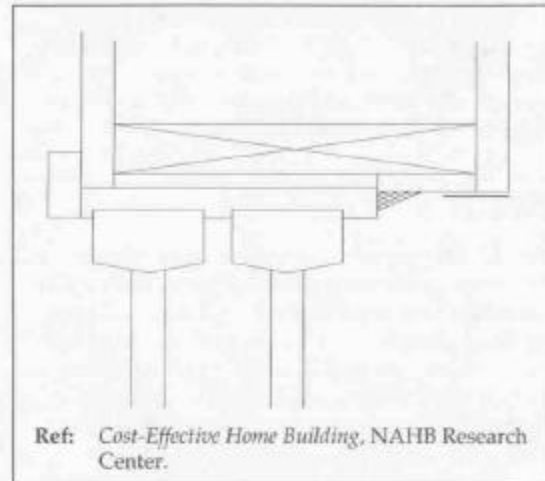
### **Eliminate Window Trim**

Window trim can be eliminated in homes by returning drywall to the face of the window. Although eliminating window trim in this manner is an acceptable cost-saving alternative and raises no code issues, the drywall finisher must pay more attention to detail than when trim is installed. (Figure 10)

### **Gypsum Laminate (Cover)**

When traditional methods are used to repair badly cracked plaster during rehabilitation, complete sections of plaster are removed and replaced with new plaster sections. This is a time-consuming, costly procedure. In many cases, an alternative

**Figure 10. Window Trim**



approach is to install gypsum board over the existing wall, which eliminates the need to work with plaster. Typically, a 1/4 inch gypsum panel is adequate. This repair method is acceptable under model codes.

Refer to *The Cost Cuts Manual*, Enterprise Foundation, for more specific information.

## **Open Kitchen and Bathroom Shelves**

Open shelves in the bathrooms and kitchens, instead of typical cabinets and vanities, provide needed storage space at lower costs. Moreover, some homeowners can also install these types of shelves themselves, which would eliminate labor costs altogether. Cabinets can be installed later as homeowner resources allow. Open shelving is acceptable under model codes.

#### **Savings from Use of Open Shelving**

Traditional hanging cabinets cost more than 3-1/2 times the cost of stained, polyurethaned plywood shelving. Further, owners can install shelving and eliminate carpentry and other labor costs. (*The Cost Cuts Manual*, pp. 4-108 to 4-115)

Ref: *The Cost Cuts Manual*, Enterprise Foundation.

## Eliminate Partitions

It may not be necessary to replace nonload-bearing partitions removed during rehabilitation, especially with the recent emphasis on open interiors. For further information refer to *The Cost Cuts Manual*, Enterprise Foundation.

## ENERGY

The HOME program includes specific energy-efficiency requirements for both new construction and substantial rehabilitation. All new construction must comply with the current edition of the *CABO Model Energy Code* (MEC) applicable to FHA-insured housing (as of October 1993 this is the 1992 CABO MEC). All substantially rehabilitated units must comply with the HUD Cost-Effective Energy Conservation and Effectiveness Standards (CEECS) in 24 CFR Part 39.

An explanation of the CEECS and examples of their application to single-family and multifamily rehabilitation work appear in *Applying the Cost-Effective Energy Standards in Rehabilitation Projects*, available from HUD USER. This section presents several cost-saving approaches for complying with the CABO MEC in new construction.

## Blown-In Insulation Instead of Batts for Ceilings

MEC currently requires that ceilings have at least R-19 insulation in the mildest climates, increasing to R-38 insulation at 6,000 heating degree days and above. Batts or blown-in insulation can be used to comply this code. In general, the installed cost of blown-in insulation is lower than batt insulation for any given R-value—one study found that blown-in insulation costs were 20 to 25 percent lower than costs for batt insulation.

For further information, refer to *Model Energy Code: Thermal Envelope Compliance for One- and Two-Family Dwellings*, North American Insulation Manufacturers Association.

## Reduce Window Areas Where Possible

Because wall requirements are based on the average performance of the entire wall, including windows, and because even the best windows do not insulate as well

as a stud wall with cavity insulation, compliance with the wall requirements of MEC becomes easier when window area is reduced. Building codes typically require that every habitable room in a home have windows in an amount that is not less than 8 percent of the floor area; minimum sizes are also required for egress. These minimums are usually exceeded in new construction. Windows cost more than walls, thus, reducing window area to the lowest amount consistent with marketability saves money even without an energy code. But reducing window area also can allow lower levels of wall insulation, or permit the use of less expensive windows with lower resistance to heat flow, while still complying with the MEC.

### Savings from Reducing Window Areas

A double-glazed metal window loses heat roughly 12 times faster than an R-20 wall.

Ref: *Energy Conservation Technical Information Guide* vol. 3: *Residential Buildings*, pp. 36-40.

## Vinyl Windows Instead of Wood Windows

Wood windows are used in some areas, in part because they have better thermal performance than windows with metal frames. Depending on the climate and window area, some houses will need high-performing windows to comply with the MEC.

Vinyl-framed windows are an increasingly popular alternative that perform comparably to wood windows in energy terms, at a significantly lower purchase and installation cost. In addition, vinyl windows do not require periodic repainting.

Refer to *Energy Conservation Technical Information Guide*, vol. 3: *Residential Buildings*.

## Foam Wall Sheathing Instead of Structural Sheathing

In some situations, compliance with the wall requirements in MEC can be difficult with 2 x 4 walls, yet there may be resistance to using 2 x 6 construction. Insulated sheathing products with

higher resistance to heat flow can be substituted for wood-based structural sheathing (except for required corner and intermediate wall bracing). Increases in the prices of wood products make insulated sheathing price competitive, and its superior thermal performance simplifies compliance with the MEC—1/2-inch plywood has an insulating value of R-0.62, while 1/2 inch of foam sheathing has an insulating value of R-2.5 to R-3.6, depending on the type of foam.

Refer to *Applying the Cost-Effective Energy Standards in Rehabilitation Projects*, HUD, for further information on this subject.

### Flame-Resistant Batt or Blanket Insulation on Basement Walls

Compliance with the basement wall insulation requirements of MEC can be accomplished with R-11 insulation in areas that have up to 8,500 heating degree days. Building an extra frame wall around the perimeter of the basement to hold the insulation and finishing the interior with drywall is an expensive alternative, but is not required by the MEC or the model codes.

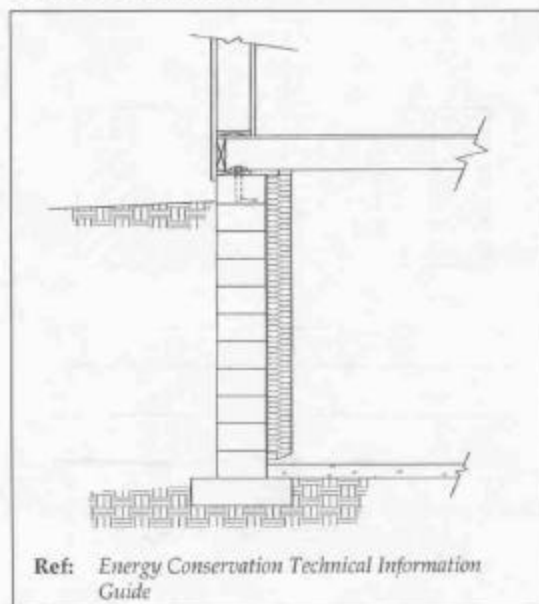
A low-cost alternative is to attach R-11 batts or blankets with a low flame-spread rating (25 or less) to 2 x 2 nailers on the floor joists over the basement, and at the bottom to 2 x 2 nailers low on the basement wall. Extra-wide (4 foot) batts with foil or other flame-resistant facing are available for this purpose. (Figure 11)

**Note:** A comprehensive interpretation of the Component Performance approach, including a worksheet for comparing a home built to the prescriptive requirements of the 1992 MEC with the same home built using alternative levels of insulation in any component, appears in *Compliance Guide to the CABO Model Energy Code*, published by the North American Insulation Manufacturers Association.

### WATER SERVICE

Insulating utilities, both main lines and service laterals, offers significant opportunities to reduce new construction costs. To a lesser extent, the opportunity also exists to reduce rehabilitation costs when underground utilities must be upgraded or replaced. Areas related to water supply that should be considered are discussed below.

**Figure 11. Flame-Resistant Batt or Blanket Installation**



**Ref:** *Energy Conservation Technical Information Guide*

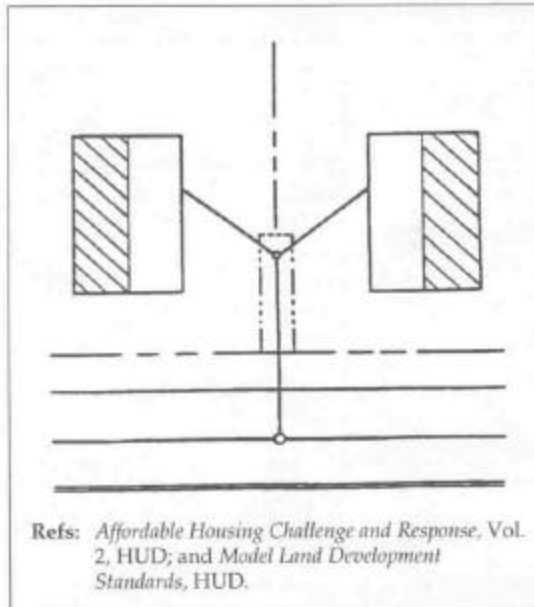
### Common Lateral Water Pipes

Many communities require that each property have its own water services, but a common or shared water service pipe, sized to handle the required water flow, can serve several homes, saving labor and material costs. Meters to measure water usage can be installed at the point where the pipe enters an individual dwelling unit. Use of common water piping is a local issue, usually regulated by the subdivision ordinance. This issue is not typically addressed in building codes. (Figure 12)

### Common Trench for Water and Sewer Pipes

Traditionally, water and sewer pipes have been placed in separate trenches as a precaution against sewer pipe leakage that could contaminate drinking water. Today, most major codes allow for installation of both pipes in a single trench, provided that the water pipe is at least 12 inches above the sewer pipe with a minimum horizontal separation of 18 inches. The cost of digging two trenches and performing two underground pipe installations is reduced by one-half. (Figure 13)

**Figure 12. Common Lateral Water Pipes**



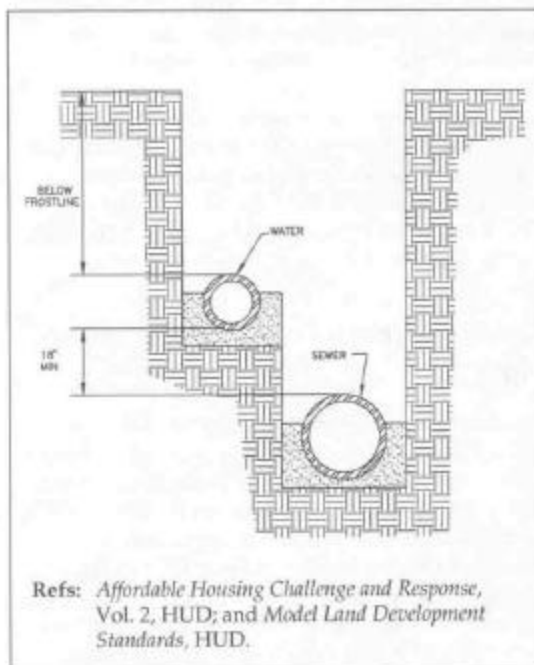
## SEWAGE DISPOSAL

Cost-saving technologies can be used for both publicly sewered property and for homes served by individual on-site waste treatment and disposal systems. Although the latest sewage disposal technologies are mainly intended for new construction, several also have rehabilitation potential, particularly on-site disposal methods. New sewage technologies can often be applied to older buildings that have failing septic systems. In fact, these methods may be the only economically sound way to rehabilitate the property.

### Common Lateral Sewer Pipes

Many communities require that every home have a separate lateral sewer pipe that connects to the main sewer pipe. A common or shared lateral sewer pipe, sized to handle the required flow, can be used to serve several homes. Common lateral sewer pipes are installed as shown in Figure 12. Refer to *Model Land Development Standards, HUD*, for further information on this subject.

**Figure 13. Common Trench for Water and Sewer Pipes**

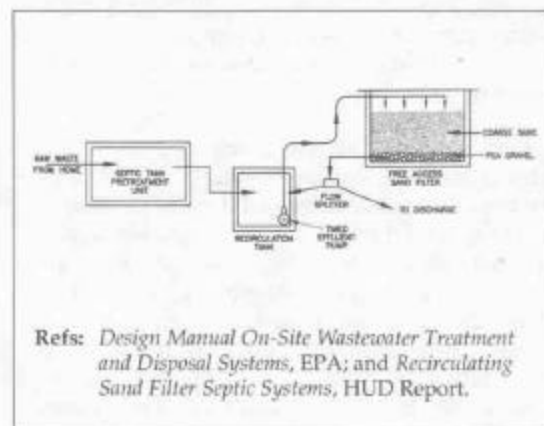


### Sand Mound Septic System

In areas where the groundwater table is elevated, where there is a shallow barrier below the soil, or where soils are slowly permeable, a conventional septic system is not suitable for wastewater disposal. Many jurisdictions do not permit new systems in these sites, which effectively reduces the land available for housing. When older, existing systems in areas with poor soil conditions fail they must be replaced with properly operating systems.

One solution in these areas is to install a sand mound or mound system. A mound system is a drainfield that is installed in a mound above the natural lot elevation on a suitable fill, usually a medium textured sand. Sand mound system design criteria are available from a variety of sources, including the U.S. Environmental Protection Agency (EPA). Mound systems designed to meet EPA guidelines are currently approved in many States. (Figure 14)

**Figure 15. Typical Recirculating Sand Filter Septic System**



Wastewater effluent from a sand filter system is of higher quality than septic tank effluent. The higher quality increases the "acceptance rate" of the soil by a factor as high as 7 to 8. This translates into a smaller drainfield, and means that smaller lots can be served by a sand filter system than by a conventional septic system.

Although they have been shown to work effectively, circulating sand filters are not yet widely recognized. Thus, local health officials should be consulted before using this type of system. Design guidelines for sand filter systems have been produced by the U.S. Environmental Protection Agency. (Figure 15)

LAND PLANNING AND DENSITY

Local zoning ordinances largely determine the amount of land available for residential development. Areas that are zoned for residential use are assigned maximum housing densities—the maximum number of dwelling units permitted per acre. Obviously, the more homes allowed on each

acre of land, the lower the per-lot cost, and the lower the house sales price. Restrictive zoning that requires low density, excessive house frontage and deep setbacks, large lots, and an abundance of open space leaves less land for homes. Inadequate supply of land to meet the demand increases the price of homes.

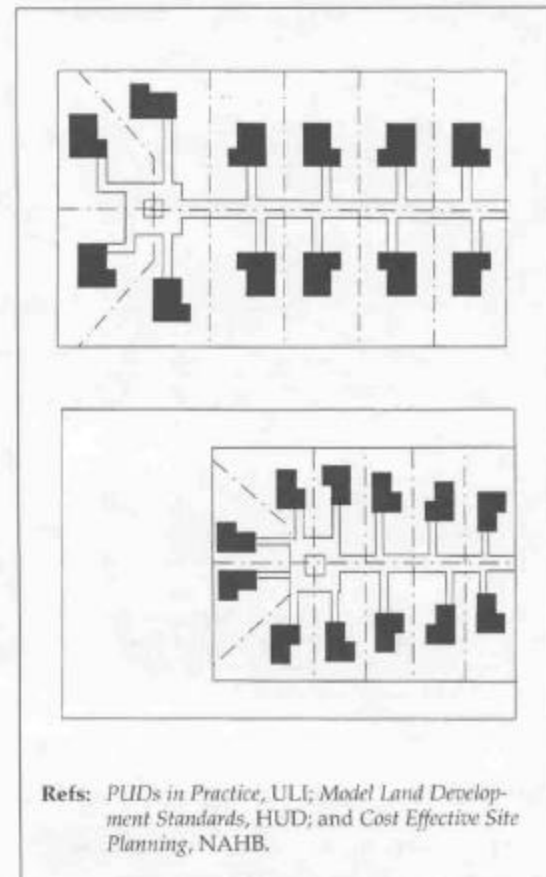
Many zoning ordinances restrict or prohibit higher density and the resulting smaller lots. But communities that have increased density limits and thus reduced the minimum lot size have demonstrated that smaller lot, higher density developments can be attractive, desirable, and affordable. Land development costs—for streets, stormwater control, utilities, and so forth—are also lower for smaller lots. It is difficult to change zoning ordinances, however, certain exceptions to density restrictions sometimes exist for affordable housing.

### Small Lot Districts

Small lots are often allowed within areas already controlled by planned unit development (PUD), planned residential development (PRD), community unit plan (CUP), and comprehensive residential development (CRD) ordinances. PUDs, etc., typically allow for reducing lot size without increasing the overall density within the development. The number of homes in the development is averaged across the entire development tract instead of measured on a per-lot basis, as in traditional zoning.

The smaller than normal lots are typically “clustered” around a common area—a court, cul-de-sac, parking, or an amenity—and the remaining area is left undeveloped. Smaller, clustered lots have lower overall site development costs, benefit from open space within the development, and, when designed under a PUD-type ordinance, maintain the zoned density. PUDs usually incorporate a variety of single-family and multi-family housing types. Setbacks, frontages, floor/area ratio, space between units, and other site requirements are usually flexible. Land development standards are typically less stringent and performance based in these developments. (Figure 16)

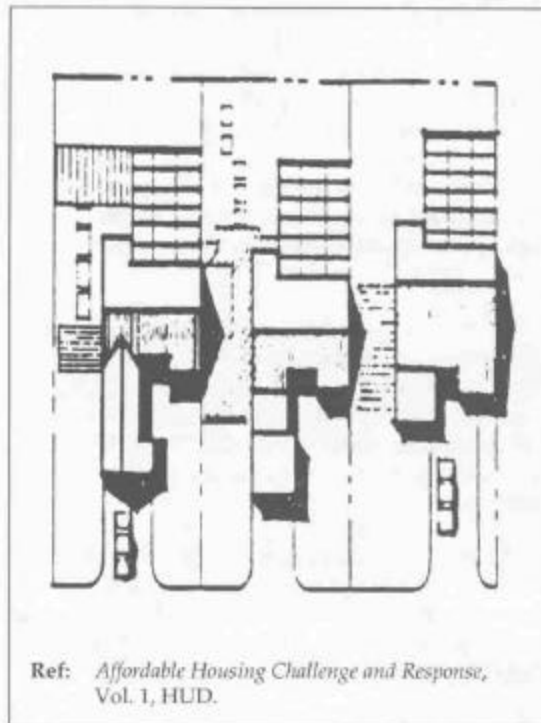
**Figure 16. Conventional and Cluster Housing Plans Comparison**



### Setback Requirements

Reduction of the generally arbitrarily determined minimum front yard, side yard, and rear yard setbacks as well as space between units, can save land costs as well as utility and infrastructure costs. Large setbacks from all boundaries place the house near the center of the lot and reduce its usability. Using the “zero-lot-line” technique, homes can be located on one or more lot-lines, creating a single, usable yard area rather than two narrow unusable sideyards. To ease privacy concerns, walls that are located on the lot lines may be required to be windowless, with a small easement granted for maintenance. (Figure 17)

**Figure 17. Typical Zero-Lot-Line Plan**



## SITE DEVELOPMENT

Two costs are associated with developing a site for housing—the cost of purchasing “raw” or undeveloped land and cost of improving or developing that land. Not only have the costs of raw lots increased, but so also have land development costs, largely as a result of excessive local requirements, i.e., wide streets and rights-of-way, and oversized water and utility supply systems.

Housing density also effects land development costs—the higher the number of homes per acre, the greater the number of homes to share land development costs. For example, land development costs per home are less for 100 homes built on a 10-acre tract than for 40 homes on the same tract. Smaller lots also reduce the linear footage of curbs, gutters, and utilities required for each house.

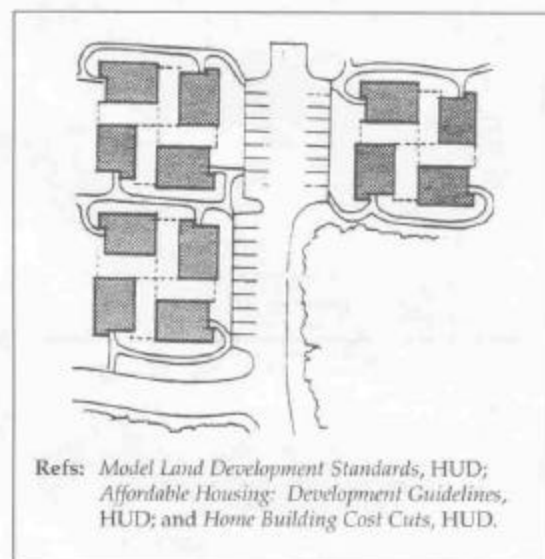
The HUD publication, *Proposed Model Land Development Standards and Accompanying Model State*

*Legislation*, offers minimum design and construction standards for residential land development designed for safe, livable, affordable residential housing. Some subjects addressed in these Model Standards follow.

## Density

As discussed above, in areas where homes are built closer together (higher density) and on smaller lots, land development costs are lower than in areas of lower density and larger lots. First, smaller homes have, for example, less street frontage, shorter utility lines, and less stormwater runoff. Second, land development costs in more dense subdivisions are distributed among a greater number of homes than in a less dense development. (Figure 18)

**Figure 18. Dense Site Development**



## Savings from Higher-Density Developments

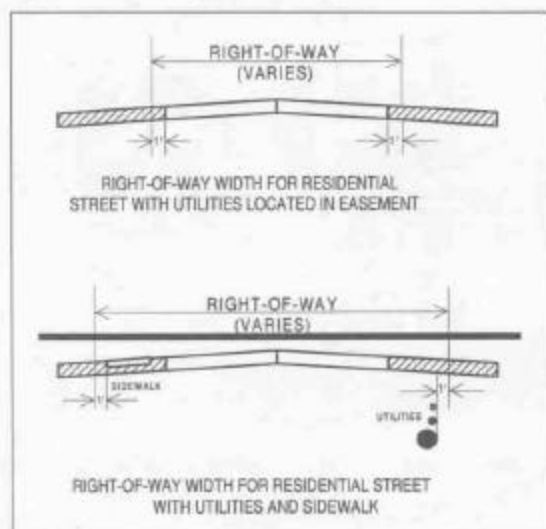
In a 1986 study of an actual subdivision in Canton, Ohio, total land development costs were \$5,735,647 or \$12,151 per unit using a conventional plan concept, and \$3,751,927 total or \$8,045 per unit using a cluster (or higher density) plan. (*Cost Effective Site Planning*, NAHB, pp. 113-120.)

## Rights-of-Way (ROW)

Rights-of-way are land areas set aside for streets, shoulders, swales, curbs, and gutters. When land was less costly, communities required excessive rights-of-way—as much as 20 feet beyond the street. The *Proposed Model Land Development Standards* recommend minimum widths of 1 foot beyond the street, for curbs and utilities, if required.

Utilities such as water, sewer, and electrical service can be installed in easements instead of rights-of-way. Easements grant passage through and/or use of privately owned property. Homeowners own the easement land. The jurisdiction determines the conditions for its use. The use of easements instead of rights-of-way makes more land available for housing. (Figure 19)

Figure 19. Rights-of-Way



### Savings from Reduced Rights-of Way

A 50-foot ROW for a 26-foot-wide street uses almost twice as much land for streets, utilities, and sidewalks as does an easement. That additional land could be used for additional house lots. Land development costs would be spread over more units, reducing the per unit cost. (*Affordable Housing: Development Guidelines*, HUD, pp. 61-63.)

Ref: *Proposed Model Land Development Standards*, HUD.

## Streets

Streets are often oversized because codes rely on standards developed for highways. But residential streets differ from highways. Highways are designed to expedite traffic and limit access. Residential streets are designed to provide safe, efficient access for vehicles, bicycles, and pedestrians. Residential streets should not be designed for speed. Wide, straight streets encourage speeding and serve as pass-throughs for nonresidents.

The *Proposed Model Land Development Standards* referenced above, recommend carefully researched minimum standards for street design and construction that will reduce costs in areas with excessive street standards. These standards are based on a hierarchy of street types based on their function. (Table 1)

For additional information on this subject refer to *Proposed Model Land Development Standards*, HUD; *Affordable Housing: Development Guidelines for State and Local Government*, HUD; and *Residential Streets*, NAHB.

Table 1. Design Parameters

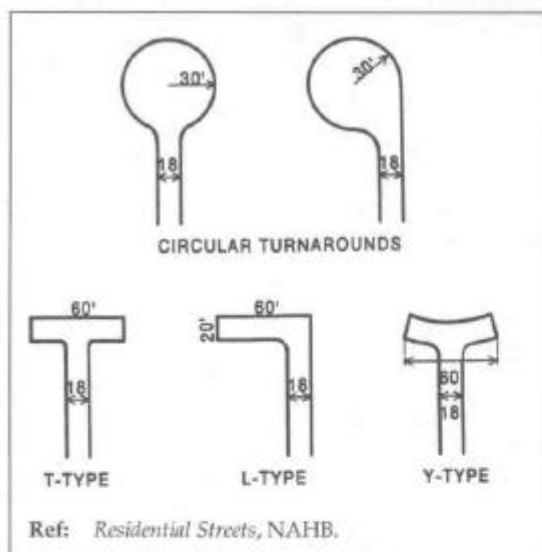
Street Type	Maximum Volume	Maximum Design Speed
Major collector	3,000 +	30 mph
Collector	1,000-3,000	30 mph
Sub collector	250-1,000	25 mph
Access	0-250	20 mph

Source: *Proposed Model Land Development Standards*, HUD, pp. 7-14.

## Turnarounds and Cul-De-Sacs

Like streets, excessively large paved "turnarounds" are expensive to construct, use valuable land, and add needlessly to stormwater runoff. Although many communities require that cul-de-sacs have a radius of 50 to 60 feet, 30 feet has proven adequate. T-turnarounds and other alternatives may also decrease paved areas and require less land, resulting in reduced per-unit land development costs. (Figure 20)

**Figure 20. Cul-De-Sac /T-Turnaround**



### Savings from Smaller Turnarounds

In Boise, ID, 38-foot-wide T-turnarounds were installed in place of three 90-foot diameter cul-de-sacs. This eliminated 8,586 feet of paving. (*Affordable Housing Challenge & Response*, Vol. 1, HUD, pp. 51-58.)

### Sidewalks

Sidewalks can be constructed on one side rather than both sides of local streets, and eliminated entirely on lightly traveled streets, dead-end streets, and cul-de-sacs. Further, sidewalks can be replaced by pathways installed where they will be used—linking housing clusters, stores, playgrounds, bus stops, and other community facilities. Less costly gravel or asphalt can be used for sidewalks or pathways instead of concrete. For additional information, refer to *Model Land Development Standards*, HUD.

### Driveways

Asphalt or crushed rock are acceptable alternatives to driveways made out of concrete, which is much more costly. Common driveways may be

provided to serve more than one house. Driveways may be designed as two wheel paths or ribbon strips instead of solid, full width concrete pads. Each of these methods of driveway design and construction reduces development costs when compared with typical construction. A side benefit of crushed rock or ribbon driveways is that more water will penetrate the soil than when concrete is used. For additional information on this subject, refer to *Residential Streets*, NAHB.

### Stormwater Management

The traditional approach to stormwater management has been to move accumulated stormwater runoff from the development through a complex system of curbs, gutters, and underground piping—a system that is expensive to build and often causes flooding downstream. Newer methods contain the runoff onsite through absorption or retention, thereby, allowing the water to drain through the soil and recharge the groundwater supply.

Grassy swales and shoulders, depressed areas running parallel to the street, can be substituted for curbs and gutters in many developments at less cost and more benefit to the environment as well. Open drainage systems cost less overall than typically closed systems and are environmentally preferable. (Figure 21)

**Figure 21. Subdivision Stormwater Management Plan**

